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by Robert N. Cook

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ENGINEERING AND ECONOMIC PROBLEMS INVOLVED IN AIRPORT LOCATION

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I am indeed appreciative of this opportunity to discuss with you some of the engineering and economic problems involved in airport location.

I know that what you have read and heard about the Greater Miami area has all proven to be true. The growth of Greater Miami to me is comparable to the rapid technological advancements that are being made in aviation. I like to think of the advancements that are being made by Miami and those in aviation as being simultaneous. The public spirited citizens of Miami, their leaders, and the Commissioners of Dade County, realize what aviation means to their community and are making provisions to provide for aviation's growth and its place in the community, not only for today but for the foreseeable future. The area's potential and rapid growth which is beyond all imagination, is at least partially due to the excellent facilities enjoyed by the aviation industry here in Miami.

Aviation is currently enjoying its fifieth anniversary, however, the aviation industry is often referred to as still being in its infancy. I personally believe that it is not, but that it has developed into a sturdy and healthy youth. Furthermore, all present trends indicate a healthy continuation of this growth.

The first flight of the Wright Brothers on December 17, 1903, was in a six hundred pound flying machine powered by a tiny twelve horsepower gasoline

engine. This flight was for a duration of fifty nine seconds at a speed of thirty miles per hour. Flight of today's modern aircraft is only measurable by the amount of fuel it carries. Recent official statements of the United States Air Force announced that they have started flight testing a research plane known as the Bell X-1A which is expected to hit 1700 miles per hour.

The advent and use of jet powered aircraft and the higher wing loading together with modern speed of conventional and jet aircraft is posing many problems to the airport engineer, planner and economist. The higher speeds and greater pay loads are requiring a lower trajectory and glide path for the take-off and landing of aircraft. This requirement is causing airport owners and operators to review their master plans for airport development and to orient their runways and traffic patterns to permit a greater acceptance and departure of aircraft with the maximum safety.

This review is also for the purpose of re-aligning or developing their runways to permit efficient and safe flight for arrivals and departures over the least sparsely populated areas. Communities and political sub-divisions are demanding such re-alignment not only for its safety value to persons and property on the ground but also to reduce the noise created by the increased horsepower of modern high speed aircraft.

Many airports today are oriented and aligned to meet this requirement, however, they are faced with a problem of protecting the approach areas required. This protection is attained by zoning or avigation easements. The question as to the best method of either zoning or avigation easements for the restrictions of certain types of construction or occupancy in these areas is debatable and is therefore, left to negotiators, with the assistance of engineers.

Positive protection of the approaches by heights limitations zoning or acquisition

of adequate property interests is mandatory, if the airport is to remain useful, for the life of the improvements.

The technological advancements in the design and use of aircraft, particularly jet, is steadily demanding a 1000 foot cleared area at the ends of the runways and approach protection in the form of avigation easements from 1500 feet to 2000 feet beyond the cleared zone. Since the advent of jet operations, one branch of the military advocates that the entire approach areas, both the 1000 foot cleared area and the 1500 foot to 2000 foot approach protection, be an integral part of the airport. Adoption of this expanded policy is a direct result of the sudden increase in the number of legal proceedings by adjacent property owners protesting the invasion of their property rights.

It has been indicated that the rights to the area used for the cleared zone should be in the nature of avigation easements. This appears to be the most economical and readily attainable due to the possibility of the present land use as compared to the approach zone. Effective protection within the two mile control zone is considered feasible; however, no definite statement can be made at this time as to the actual cost that would be involved.

In this connection, it is believed that acquisition of the cleared zone can be accomplished, except at those locations where the land use is such that the acquisition costs would be entirely out of proportion to the value of the airport.

Avigation easements should not only effect and place limitations on height of the buildings but also should cover "the right of flight", thereby eliminating any nuisance claim for noise.

The major airports of our larger cities which have increasing traffic resulting from the terrific gains in scheduled airline operations are currently in a quandary as to what will be the ultimate requirements for the length of the runways, to

satisfy and accomodate equipment of the scheduled carriers. I have been advised by authorities in the Civil Aeronautics Administration that their Technical Standard Order N-6A, indicates the maximum that the Federal Government will participate in the development of runways, taxiways and landing strips.

Many major cities, prior to World War 11, believed that a 640 acre airport with an omni-directional configuration of its runways of three to four thousand feet in length was the ultimate and satisfactory solution for their airport needs. The air carriers did little to correct this assumption. The higher speed and greater wing loading of our modern aircraft has made the omni-directional configuration of runways obsolete. This is particularly true where hourly aircraft operations exceed forty in any given hour. The recommended design of parallel runways for simultaneous landings and take-offs is now considered for the foreseeable future as the most adaptable for safe and efficient operations. The parallel system results in obtaining the highest acceptance rate, arrivals and departures, of aircraft under any and all weather conditions.

The electronic engineers and the aircraft controllers state that the best aircraft patterns for landing and take-off of aircraft is obtainable with the parallel runway system. Provision of a parallel system, in which all landings are made on one runway and all take-offs on the other, can provide a theoretical maximum of sixty landings and sixty take-offs or 120 plane movements per hour under contact conditions or VFR (visual flight rules). In some geographical areas, consideration must be given to occasional high velocity winds not aligned with the basic parallel runways. In such instances approximately a 90^{o} non-intersecting runway to the parallel system is recommended.

In general, it has been found that where an airport has been planned for the efficient operation of a four engine piston aircraft, the introduction of turbine

or jet powered aircraft will raise no new problems as far as runway length and width is concerned.

Many representatives from the airline and aircraft industry have stated that various braking techniques to shorten the required landing distance of jets are in the course of development and they have assured airport operators that the airport requirements for four engine piston aircraft will satisfy jet aircraft. The industry would hesitate to recommend the use of outrigger landing gear or chutes on the aircraft because of the economies involved. All assurances are being made by the industry to the airport operators that the widening of the runway will not be necessary.

One of the most vexing problems pointed up by the industry however is the design and use of the taxiways. Any delay in taxiing results in a serious economic penalty, particularly for jets, because of fuel consumption. The terminal area should be planned to reduce taxiing to a minimum. The present principles of terminal apron design are not affected by the advent of jet aircraft.

A major problem for airport engineers and planners is that of providing for economical ground handling facilities to service aircraft. By service to aircraft, I mean affording the highest degree of convenience to the passengers, such as expediting the handling of baggage and cargo. The reduction of the time that the aircraft is on the operational ramp is highly important to both the air carrier and the airport owner. Aircraft time utilization of the ramp operational area is one of the major problems of air transportation. Its importance cannot be overstressed because of its contiguousness with the design of taxi-ways, aircraft loading positions, and the housing of airline operational facilities.

Most of our major airports in the last year have increased their runway operations on an average of 20%. The increase in runway use is approximately proportionate to the air carrier's increase in equipment with greater seating capacity and pay

loads. These increases together with the air carrier's scheduling longer flights with greater pay loads is requiring more time on the ground for loading and fueling. More efficient and practical ways and means for ground handling of aircraft must be found.

The ground facilities within the airport boundaries are the major bottleneck of air transportation today. This is due to the accelerated installations of more and newer air navagational aids resulting in heavier demands on the runways and taxi-ways. Such an increase in air traffic and air transportation requires suitable landing facilities. Unless such facilities are provided the gains being made in flight will be nullified in many cases unless the aircraft can be afforded proper ground circulation, berthing and handling. This problem is aggravated at our major terminals because the larger cities are air route terminals or changing-over stops.

A great proportion of the air schedules at our major cities are terminating flights which are commonly described by the industry as originating or turn-around flights. These types of flights consume considerably more ground time than through flights. Therefore, ramp and operational space for the loading and un-loading of aircraft at our major cities is at a premium.

As you gentlemen are all aware, the DC-6 or the Constellation, currently the favorities of our aircarriers, require a 200 foot diameter ramp in order to park in front of a terminal building for the purpose of discharging their passengers and cargo.

Recent studies have revealed that many of our major airports are running out of desirable parking and unloading space. One particular airport owner recently asked me how he could provide for the parking of approximately thirty such type aircraft at his airport without highly inconveniencing the air carriers and their

users. The inconvenience of which he spoke was the possibility of a passenger arriving at gate position number thirty to change to an aircraft at gate position number one. The distance between the two gate positions is 6,000 feet or better than one mile.

The question was how does one handle baggage or cargo from one plane to another without it becoming a costly and time consuming operation. Also, and make no mistake, the airline passenger is a person who does not like to be inconvenienced by walking a mile in the rain or bad weather.

Many proposals and ideas have been proffered to users and owners of airports to facilitate the handling of aircraft and their passengers and cargo in terminal areas. Some believe that the towing of aircraft to a central loading and unloading point is the answer. Also that the towing of aircraft to such a central point for the purpose of firing up the engine would greatly reduce the noise and hazard on the operational ramp in the terminal area. The urgency of noise reduction efforts becomes more evident when we realize that gas turbines of the turbo jet are inherently noiser than the piston engine. Noise in jet aircraft presents a basic problem in that the jet blast produces both the noise and the power and if the jet is muffled, we eliminate the power.

Many people in and out of the aviation industry have complained of the high operating costs connected with the current practices and procedures used for the loading and unloading of the passengers and the cargo. I have been informed from reliable sources that 40% of the cargo revenues are expended for cargo handling. The Civil Aeronautics Board's records reveal that in excess of $37,000,000 resulted from cargo revenues.

Maximum utilization of airport property must be sought and obtained in order that all possible revenue potentials of the airport are developed. Many non-aeronautical uses should be fully explored. Airport owners and operators should be encouraged

to utilize all available areas on an airport that will not interfere with the landings and take-offs of aircraft. I know of many airports that contain as high as 4,000 acres with only one runway and a small terminal building. No thought or planning has been given to satisfactorily using the balance of the acreage for non-aeronautical purposes.

Maximum utilization of airport property can be accomplished in many ways and result in much needed revenue to properly develop, operate and maintain the primary facility, which is the airport. Property outside the minimum lateral clearance from the central line of the runway could be put to many industrial uses such as perhaps factories, assembly plants, etc.

Many airports have been developed and are being developed with one primary objective, that is, to provide a place for the landing and take-off of aircraft with no thought being given to the development of the remainder of the property. Therefore, engineers should stress to the communities and political subdivisions owning and operating airports the advantages to be gained by having an engineering firm review their master plan for airport development and to prepare for them a feasibility report for the complete utilization of the property concerned. Such a feasibility plan should recommend capital improvements of a nature which would be self-sustaining.

To my knowledge, 65% of the master airport plans are obsolete. No thought is being given in many instances to making obsolete the omni-directional configuration of the runways. The annual maintenance cost for snow removal alone for omni-directional runways at many airports would finance a sound engineering study and a plan for the development of the airport. Many plans and studies of the airport need revision in accordance with most recently developed criteria or changes in local conditions.

Probably the most obvious factor influencing the location of an airport is its proximity

to the ultimate destination and source of passengers and cargo. It is natural, therefore, that the time proximity from an airport to the destination and source of passengers and cargo be considered as one of paramount importance. Ground time at some locations, i.e., from the airport to downtown or the hotel area, is as great as travel time in the air. This is particularly true when the air trip is approximately 250 miles or a one hour flight. It is interesting to note, in this general connection, that airports have influenced the patterns and growth of community areas, paralleling the effects of railroads and highway development.

With regard to the design and use of pavements at airports, service records have shown definitely that taxiways, aprons, turn-arounds, and warm-up pads at ends of runways are the most critical areas from the standpoint of aircraft use. This results from the numerous repitions of loads due to the flow of traffic in these critical areas. In addition, these areas are subjected to impact produced by slow moving aircraft as well as vibrations resulting from engine operations.

High speed moving loads are less critical than the static load.

Pavements located at the loading area, the warm-up aprons and pads and the turn-around areas at the end of the runways should be of sufficient stability to withstand the heavy shearing stresses occasioned by short radius brake turns, the vibration of engine-run-up, and from drippings of gas, fuel and oil.

We must constantly be on the alert to provide today the airport facility needed for tomorrow.

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